

TECHNOLOGY TRANSITION FOR HYBRID WARFARE

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TECHNOLOGY TRANSITION FOR HYBRID WARFARE

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The views expressed in the academic research paper are those of the author and do not necessarily reflect the official policy or position of the US Government, the Department of Defense, or any of its agencies.

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ABSTRACT

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The Department of Defense (DoD) and the Army must be able to develop and transition new technological capabilities to meet both current urgent and future operational needs of the warfighter. The technology must enable the military to successfully defeat an enemy engaged in a hybrid warfare that entails components of both irregular and conventional conflicts. As a result of hybrid warfare, the science and technology (S&T) program must not only provide long-term capabilities for conventional warfare but also be adaptive and able to rapidly provide capabilities for asymmetric warfare.

A strong S&T program is critical for technology transition and maintaining military dominance in hybrid warfare. The S&T community must develop systems that provide rapid incremental improvements needed to overcome adaptive enemies as seen in the current irregular warfare engagements in Afghanistan and Iraq. At the same time, the science and technology base must provide the disruptive technologies to defeat future conventional enemies. This paper examines the Army S&T base, the process of transitioning this technology into the acquisition process and provides recommendations for reforms to support hybrid warfare.

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TECHNOLOGY TRANSITION FOR HYBRID WARFARE

Introduction

The Department of Defense (DoD) and the Army must be able to develop and transition new technological capabilities to meet both current urgent and future operational needs of the warfighter. The technology transition must enable the military to successfully defeat an enemy engaged in a hybrid warfare that entails components of both irregular and conventional conflicts.¹ As a result of hybrid warfare, the science and technology (S&T) process must not only provide long-term capabilities for conventional warfare but also be adaptive and able to rapidly provide capabilities for asymmetric warfare.

The urgency for rapid technology insertion is a direct result of ongoing irregular wars in Afghanistan and Iraq. As stated by the Defense Science Board (DSB) in referring to the need for reforms, “today’s adversaries are changing their tactics, techniques, and procedures at an accelerated pace, heightening the need for US forces to respond rapidly to new threats.”² The operational community has identified weaknesses in its ability to engage in irregular warfare. Marine Corps General, James M. Mattis, Commander, US Joint Forces Command has stated, “We are not superior in irregular warfare...and that's what we've got to be.”³ The number of urgent operational requirements has grown significantly due to events in Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF). Over 7,000 urgent operational needs have been generated since the wars began.⁴ For example, the enemy has utilized improvised explosive devices (IEDs) successfully to attack coalition forces. The threat of IEDs has driven urgent requirements for such capabilities as the Mine Resistant Ambush Protected (MRAP) and Counter Radio Controlled Improvised Explosive Device Electronic Warfare (CREW) devices to protect US forces. New sensor systems for platforms and UAVs have been required to detect and identify the enemy. New weapons and soldier equipment are urgently needed to lighten the soldiers load and allow US forces to engage the enemy in the rugged mountains of Afghanistan.

Urgent needs have stressed an existing acquisition process, supported by an S&T base that historically has been focused on providing long-term capabilities to defeat a conventional enemy. As Secretary Gates stated, “irregular warfare capabilities are largely ignored in the acquisition system, which is overwhelmingly focused on future operational capabilities and not on the irregular wars we are currently fighting.”⁵ The transformation to balance the focus of the S&T base on the current fight is ongoing. S&T research is heavily influenced by the current urgent warfighting requirements such as technologies to defeat and detect IEDs. Ad-hoc agencies such as the Rapid Equipping Force (REF) and the Joint IED Defeat Organization (JIEDDO) provide the Army S&T base with funding to rapidly transition technologies available for urgent warfighting needs. In addition, agencies such as the US Army Research Development and Engineering Command (RDECOM) have sent their military officers and NCOs as well as their civilian counterparts forward to the battlefield to work with operational commanders to provide S&T advice and get a better understanding of warfighter needs. Additionally, much of the focus on technology insertion has shifted to the rapidly changing commercial sector. All these actions indicate that the S&T strategy is being re-focused to find a proper balance between the technology needs for the current fight as well as the technology needs of the future force.

The capability for rapid technology insertion is important but not the total solution to the capabilities required for today’s military. The long-term systems developed must be adaptable to support full spectrum operations. Quadrennial Defense Review (QDR) 2010 states that the US military also “needs a broad portfolio of military capabilities with maximum versatility across the widest possible spectrum of conflict.”⁶ Key challenges impact DoD ability to maintain capabilities across the full spectrum of conflicts. These challenges include the breadth of technologies needed, the speed of technological change, the availability of critical technologies to the enemy, and costs.⁷

Future hybrid wars will demand a greater range of technology developments for military application. Hybrid threats are defined as the “full range of modes of warfare, including conventional capabilities, irregular tactics and formations, terrorist acts that include indiscriminate violence and coercion, and criminal disorder.”⁸ In these wars, an enemy will identify strengths and weaknesses and exploit any vulnerability. The US

Army today has roles to play in defending the homeland against terrorist attacks, fighting terrorists and insurgents in Afghanistan and Iraq, as well as preparing for conventional conflict. Not every capability gap can or should be solved by a material solution. The first choice for filling a gap is a non-material solution through changes in doctrine, organizations, training, leadership and education, personnel and facilities. In those cases where these non-material solutions cannot meet the existing capability gap, new material solutions will be needed supported by new technologies.

The speed of technological change provides the US the opportunity to continue to develop new capabilities for hybrid warfare. Examples include continuing breakthroughs in information technology processing power as well as stronger and lighter materials for military platforms. As a result of technological change, existing technologies can become obsolete very quickly. The right choices have to be made.

The widespread availability of technologies also enables less advanced enemies to use available technologies against US forces in unforeseen ways. The QDR 2010 states “globalization has transformed the process of technological innovation while lowering entry barriers for wider range of actors to acquire advanced technologies.”⁹ For example, the enemy uses commercially available cell phone technology to trigger IEDs and kill or injure soldiers. Recently, insurgents in Iraq hacked into live video feeds sent from Predator drones using an inexpensive off-the-shelf software program available for purchase on the Internet.¹⁰ Through this inexpensive hacking, the enemy was able to electronically eavesdrop on critical US military surveillance and reconnaissance technology. The S&T process must be able to capitalize on the speed of technological change and help defend against critical technology in the hands of a hybrid enemy.

Cost will be a key factor in defeating a hybrid enemy. Available funding will constrain what technology solutions can be made. The DoD has funded a large quantity of procurements through supplemental funding for both OEF and OIF. Senior DoD officials indicate that strains on the economy and shifting national priorities will lead to the end of this type of funding.¹¹ DoD must eliminate overall inefficiencies in the process that waste money and results in cost growths. The right tradeoffs must be made and the most cost effective technology solutions must be chosen. Failure to do so will result in less procurement of new capabilities for future warfare.

Two types of technology insertion will be needed to defeat a hybrid opponent. First, rapid short-term incremental improvements will be needed to adapt to the changing tactics and adaptations of the enemy conducting irregular warfare. Second, disruptive technologies will be needed to retain long-term technological superiority in conventional warfare. Incremental improvement is the most common for various reasons. First, the S&T and acquisition communities have existing programs in place for incremental change incorporation, which make the technology transition path clear. Second, as incremental change normally builds on an existing system in the field, the user community already has concepts for its use. Incremental technology improvements can improve key aspects of a system such as greater range, lighter weight, speed and accuracy. Too much focus on incremental change, however, could cause new opportunities to replace a legacy technology with a revolutionary technology to be missed. Disruptive technologies are the second type of technological change and involve revolutionary concepts involving large technological leaps that fundamentally change the way warfare can be executed. Examples of disruptive technologies include the atomic bomb, radar, and unmanned aerial vehicles. In the desire to achieve rapid technology insertion to defeat a rapidly changing hybrid enemy, the DoD cannot focus all efforts on incremental technology improvements. Incremental change will not solve all the capability needs of the warfighter or all the unforeseen opportunities. The Army S&T program must effectively allocate resources to support the incremental technical changes and disruptive technical breakthroughs necessary to defeat a hybrid enemy.

A strong S&T program is critical for technology transition and maintaining military dominance in hybrid warfare. The S&T community must develop systems that provide rapid incremental improvements needed to overcome adaptive enemies as seen in the current irregular warfare engagements in Afghanistan and Iraq. At the same time, the S&T base must provide the disruptive technologies to defeat future conventional enemies. This paper examines the Army S&T base, the process of transitioning this technology into the acquisition process and provides recommendations for reforms to support hybrid warfare.

The Science and Technology Base

The technology base is comprised of three components: a DoD technology base, US civilian sector base, and foreign technology base.¹² Together, all these components comprise the available technologies that have the potential to transition into an acquisition program. This paper focuses on the Army's effectiveness in utilizing the first two components.

The Army's S&T strategy is to "pursue technologies that will enable the future force while simultaneously seizing opportunities to enhance the current force."¹³ S&T investment is needed to gain an advantage in military power over potential hybrid adversaries that possess both conventional and asymmetric capabilities. Army S&T capabilities are developed within the framework of the QDR and Director, Defense Research and Engineering strategy. Army S&T needs are established by the Training and Doctrine Command's (TRADOC's) Army Capabilities Integration Center (ARCIC) processes.¹⁴

The S&T program is executed by universities, university affiliated research centers (UARCs), industry, and science laboratories. Their activities are managed in three budget activities that progress linearly as the technology matures: basic research, applied research, and advanced technology development. Basic research has a long-term focus involving scientific studies to increase knowledge and understanding in broad areas of science such as computers, materials, and electronics. Basic research has the potential for discovering breakthrough and disruptive technologies with as of yet unforeseen applications. Applied research is focused on the mid-term maturing of technologies, with military applications, prior to consideration for transition to the next phase of advanced technology development. The advanced technology development phase of development demonstrates technical feasibility at system and subsystem levels, and is the final step in S&T prior to insertion into the acquisition process.¹⁵

The Army's technology investment areas are aligned to TRADOC Future Operational Capabilities (FOCs). FOCs are generated through the TRADOC ARCIC process. The ARCIC "defines and describes capability gaps for the future and current forces and identifies technology shortfalls"¹⁶ The FOCs are force protection, ISR, C4,

lethality, medical, unmanned systems, soldier systems, logistics, military engineering and environment, advanced simulations, rotorcraft, and basic research.¹⁷

Headquarters Department of the Army designates the highest priority S&T efforts as Army Technology Objectives (ATO) through yearly guidance. ATOs are “focused efforts that develop specific S&T products within cost, schedule, and performance metrics assigned when they are approved.”¹⁸ The Army does not designate all funded technology programs as ATOs since they are part of a process to deliver technology within a scheduled timeframe based on need. ATOs, by their nature, must be fairly well understood. Other, less understood technologies are funded without the expectations and schedule of an ATO.

The US Army Research, Development and Engineering Command controls roughly 80% of the Army’s S&T enterprise.¹⁹ RDECOM was formed in 2004 and to bring together a number of functionally aligned Research Development and Engineering Centers conducting research in areas such as aviation and missile technology, armament research, soldier systems, communications and electronics, tank and automotive, simulation and training, and chemical and biological weapon. RDECOM also oversees the US Army Research Laboratory (ARL), which is the Army's corporate basic and applied research laboratory.²⁰ RDECOM has working relationships with industry, academia, and other government agencies in order to support development of necessary technologies. RDECOM coordinates directly with TRADOC and Army Program Offices to support technology development.

Leveraging of Commercial Sector Science and Technology

Only a portion of technologies available to the US Army comes from DoD investment. The proportion of funding dedicated by DoD in relation to US civilian markets and foreign technology has decreased significantly over the past 50 years.²¹ As a result, the military has shifted much of its focus to leveraging commercial developments. This change in developments creates new challenges for the S&T community in that it is much more critical to retain a thorough knowledge of S&T developments worldwide. Army laboratories have various programs to maintain abreast of and capitalize on commercial technology developments. Examples of programs designed to capitalize on

the commercial S&T sector include the Cooperative Research and Development Agreement (CRADA), the Small Business Innovation Research (SBIR), Collaborative Technology Alliances (CTA), Independent Research and Development (IR&D), and capability brokers.

CTAs are formalized efforts between the S&T community and outside industry and universities to jointly manage Army technical work and complementary work by the consortia. The purpose of CTAs is to allow the S&T community to gain basic and applied research knowledge and expertise in areas where it previously had none. The first use of CTAs was in the 1990's in order to rapidly gain information technology knowledge required for battlefield digitization.²² There are a variety of CTAs in a broad range of areas. One example is the Robotics CTA involving ARL, Carnegie Mellon University, and General Dynamics Corporation. Robotics shows great promise in hybrid warfare with the potential to replace the soldier in conducting hazardous operations such as explosive ordnance disposal. The goal of the Robotics CTA is to "focus technology required to permit inanimate systems (or sub-systems) to perform in a seemingly human fashion."²³ CTAs are useful in ensuring that the Army can capitalize on and guide basic and applied research with potential for breakthrough military.

CRADAs are agreements between DoD laboratories and one or more commercial partners to facilitate technology transfer between the parties for their mutual benefit. Under a CRADA, an industry participant may contribute resources such as personnel, services, property and funding to the effort. The government can contribute all the same but not funding.²⁴ The US Army Communications-Electronics Research, Development and Engineering Center recently signed a CRADA with Microsoft to share research in support of developing multi-touch technology. The technology will study the applicability of multi-touch technologies to command and control systems. "Not only does this partnership help us to quickly adopt or adapt new commercial technologies to meet Army needs, it also helps us to be in front of the implementation edge by better understanding what is coming over the commercial sector horizon," said Dr. Gerardo J. Melendez, director of C2D.²⁵ An agreement such as this allows the Army to work hand and hand with an information technology leader to provide the best solution to meet warfighter requirements.

SBIR provides small businesses and research institutions with opportunities to participate in government-sponsored research and development (R&D). Through SBIR, DoD provides seed money for high-tech small business to use for innovative product and technology development. For the Army, this investment results in a technology, product, or service that can potentially be used. The small business or research institution has the potential benefit of a product that can be commercialized.²⁶ The US Army Aviation and Missile Research and Development Engineering Center is currently using the SBIR program to put new, lighter, stronger and cheaper composite materials into its missiles. Such technology upgrades can increase the range and lethality of the missile. Existing programs that will benefit from this technology development include existing programs of record such as Joint Air-to-Ground Missile, the Non-Line-of-Sight Missile, and the Javelin missiles. The SBIR program is used to “produce materials that can become commercialized and thus widely adopted to make those technologies and materials available and affordable for Army missile programs.”²⁷ The SBIR involves a small company using research and development from universities and other companies and moving that technology forward to improve missile technology. If the company is successful in commercializing its technology, then the benefit to the US Army could be further commercial development as well as a cheaper and more widely available material.

IR&D is research and development conducted by defense contractors that is independent of DoD control. DoD funds IR&D through reimbursement of “allowable IR&D costs as indirect expenses under defense contracts.”²⁸ Through IR&D, DoD contractors are encouraged to conduct IR&D activities that “may lead to superior military capability in a broad sense, or may lower the cost and time required for providing that capability.”²⁹ IR&D is a great benefit to the DoD because industry research and development supplements DoD-funded activities and utilizes industry expertise and innovation. Government R&D organizations remain abreast of industry activities by hosting technology interchange meetings. At the technology interchange meeting, industry leaders present their IR&D projects for government awareness and feedback. There are numerous examples of IR&D activities that are maintained on the government’s Defense Technical Information Center (DTIC) database. The MRAP has gained much IR&D attention from companies interested in participating in what they see

to be a potentially large market. IR&D projects are underway to fund MRAP armor technologies as well as funds to extend the life of current production lines.³⁰ Such IR&D activities speed development of innovative technologies for the Army.

Another innovative program that allows remaining abreast of commercial technologies is through the use of capability brokers. The Defense Information Systems Agency has begun to use “independent technology capability brokers to help agency officials match DoD’s needs with the universe of possible sources for solutions.”³¹ The plan is to use these brokers to more “systematically identify best of class technologies outside of the defense sector that have potential military IT applications.”³² The implementation of capability brokers will differ with the different organization. The program, does demonstrate however, a fundamental shift from a government development focus to first focusing on the commercial sector. Army S&T should adopt this innovative approach.

The Army S&T program gains great benefit when using the commercially available products and technology. By utilizing the commercial sector as a first choice, S&T investments can be focused on filling gaps in existing technology and not re-creating advances in the private sector. Army laboratories have developed various programs to maintain awareness of and capitalize on commercial technology developments. Such approaches show great benefit for both long-term capability development and short-term rapid technology insertion.

Warfighter to Research and Development Laboratory Interface

Successful technology transition in hybrid warfare requires close interaction between the military warfighter and the S&T base. The necessity for direct access has been exemplified by the REF, which has sent military officers into Afghanistan and Iraq to better understand warfighter needs. This type of interface is also needed between the Army S&T base and the warfighter. The US Army has recognized the importance of understanding current warfighter needs and has allocated resources to this effort to support the current fight.

RDECOM has recognized this need and has begun this transformation to support close interaction with the warfighter engaged in combat operations.³³ RDECOM has

deployed Science and Technology Acquisition Corps Advisors (STACAs) to Operation Enduring Freedom and Operation Iraqi Freedom. The STACA in Afghanistan provides “operational commanders assigned to US Forces-Afghanistan with S&T support in order to enhance their warfighting capability in the OEF Theater of Operations. The STACA to OEF provides the link from the field commanders to the US national R&D community.”³⁴

The mission of the RDECOM S&T advisor is to have close interaction with the operational commander to identify operational issues that may be solved with new or emerging technology. The S&T advisor communicates science and technology capability gaps back to the RDECOM quick reaction cells (QRCs) located at each of the RDECOM subordinate commands. These QRC staffs coordinate RDECOM reviews to determine what technologies are currently available or can be quickly adapted to support operational commanders’ needs.³⁵ The timeline for this analysis is on the order of weeks. Only preliminary work can be conducted without a valid requirement. Therefore, in parallel to this process, the S&T advisor supports the operational commander’s requirements development process and the generation of Joint Urgent Operational Needs (JUONS), Operation Needs Statement (ONS), or REF 10-Liner.

The S&T advisor advises the operational staff on the available technologies. This feedback process includes advising the commander on the probability of system success and the applicability to current tactics, techniques, and procedures. This feedback process greatly shortens the more formal requirements development process and helps to ensure that the R&D community understands the user needs and planned tactics, techniques and procedures. This feedback process also ensures that the operational commander has an understanding of the technical maturity and capability and limitations of existing technology.

Another final key role of the S&T advisor is to work with evaluation commands such as Army Test and Evaluation Command (ATEC) Forward Operational Assessment teams to review the success of fielded technologies. This effort is critical to determining whether the technology is providing operational benefit and whether its efforts should continue and be transitioned to a program of record.

The warfighter to R&D interface that the Army has established is a key to understanding the warfighter needs and is critical to rapid and effective technology insertion to defeat a hybrid enemy. The use of S&T advisors can greatly assist the technology development process by ensuring that engineers have a rapid and thorough understanding of capability gaps as they arise. This allows some research and study while the formal requirement is generated. The Army S&T community has recognized this need and has begun to resource S&T advisors at various levels of warfighting commands. This allocation of resources should continue and be recognized as a critical aspect of defeating a hybrid enemy. This close interaction should complement and not replace the current role that organizations such as TRADOC and ARCIC play in relaying requirements to the S&T community.

Technology Transition

Successful execution of technology insertion for hybrid warfare will require a robust technology base and a streamlined transition path to the warfighter. Technologies from the S&T base, with military utility, are transitioned from the S&T base to the acquisition process for incorporation into a program of record. This process of transitioning technological capabilities from the S&T base and into the acquisition process has proven to be a major barrier and termed the *valley of death*.³⁶ Successfully crossing the valley requires a coordinated effort between the user community, the R&D center, the sustainment community, and the acquisition Program Manager (PM).

Technology transition occurs within the context of three decision support systems. These decision support systems are Joint Capabilities Integration and Development System (JCIDS), Defense Acquisition System, and the Planning, Programming, Budgeting, and Execution (PBBE).³⁷ Each of these processes must work collectively to determine the requirements, allocate funding, and provide a process to deliver safe, suitable, and effective material solutions to the warfighter. The rapid acquisition process that has been developed and the numerous ad-hoc rapid fielding organizations that have been stood up since the wars in Iraq and Afghanistan have all implemented modifications or workarounds to these processes to speed technology insertion. Many of these

modifications should be institutionalized into the technology transition process to best support the technology requirements of hybrid warfare now and into the future.

Requirements Generation and Analysis

Requirements generation and analysis is an integral decision support system impacting technology insertion. The requirements analysis process identifies capability gaps and generates a user needs statement. The role of the material developer is to then generate a material solution that meets the prioritized need identified in this user needs statement. DoD and the army have a deliberate and rapid process for the generation of user needs. JCIDS is the deliberate requirements generation process utilized by the Department of Defense. The Joint Rapid Acquisition Cell (JRAC) process was developed to rapidly validate warfighter requirements.

The JCIDS process is best suited for the enduring requirements that result in large-scale procurements that shape the force; these requirements involve long-term technological development to defeat an advanced foe in a conventional warfare. The JRAC process supports immediate warfighter requirements that are generated in irregular warfare that should be supported by mature technology. The JCIDS process and the JRAC process are both necessary to support technology insertion against a hybrid enemy.

JCIDS supports the acquisition process by “identifying and assessing capability needs and associated performance criteria to be used as a basis for acquiring the right capabilities, including the right systems.”³⁸ The JCIDS process is initiated with a Capability Based Assessment (CBA), an analysis conducted to define the issues, provide estimates of current and future capabilities, and provide recommended actions. The CBA is conducted through three separate studies: a Functional Area Analysis (FAA), Functional Needs Analysis (FNA), and a Functional Solutions Analysis (FSA). To streamline the process, the FAA and an FNA are first conducted to produce a Joint Capabilities Document, which is sent to the Joint Requirements Oversight Council. This council then decides whether to act on the needs identified in the assessment and will assign a sponsoring service or agency to do one or more FSAs.³⁹ The result of a CBA can be an Interim Capability Document (ICD) if after a complete analysis of possible non-material solutions shows that only a new system or upgrade of an existing system

can meet the capability need. One critical problem with the CBA process is that they are very time intensive. Most CBAs take 11 months or longer to complete.⁴⁰

The JRAC process was established to rapidly validate warfighter requirements and resource those requirements with a goal of fielding a solution in days, weeks or months. The JRAC process was established to complement and not replace the JCIDS process by focusing on current year fielding. The Army has also set up a similar process to support service specific Army operational need statement (ONS) using a similar process. Combatant commanders initiate the joint rapid acquisition process with the submission of Joint Urgent Operational Needs (JUONS). The JUONS are forwarded to the Joint Staff/J-8 and then to an appropriate Functional Capabilities Board (FCB). The FCB charts a working group with representatives from the Joint Staff, Office of Secretary of Defense (OSD) Comptroller and OSD Program Analysis and Evaluation. The FCB validates, prioritizes, and provides a funding recommendation for the JUON. The JRAC can approve the decision and will request the concurrence of the service or agency that is often the designated source of funding.

A key aspect missing from the JRAC that differentiates it from JCIDS is a formal DOTMLPF analysis and analysis of alternatives. In JCIDS, the analysis of alternatives is completed by the user representative supported by technical experts. For a JUONS, the analysis is often just informally based upon the experience and expertise of the combatant commander's staff. This staff, engaged in combat operations, does not have the time or manpower to conduct an in-depth analysis of alternatives. It is therefore more likely that a material solution chosen in the urgent needs process will not be the most effective or efficient solution available. The combatant command may get the 50% solution but it may be going down the wrong material solution path needed to provide the long-term material solution for the Army. For this reason, a JUONS solution should be targeted for small quantities and closely studied after fielding.

The timeline for completion of the JCIDS and JRAC processes is also a critical factor in the technology insertion for hybrid warfare. Completion and staffing of a JUONS is measure in terms of days and weeks whereas producing the ICD take closer to a year. The rapidity to which the JRAC process proceeds makes it ideal for supporting

small-scale technology insertion needed to defeat an adaptive foe engaged in hybrid warfare.

For hybrid warfare, both JCIDS and JRAC type processes are needed. The JRAC process should be used only for urgent requirements where a rapid technology insertion on a limited scale is needed. JCIDS should remain as the process for generating requirements for the future forces. In addition, the two processes must be linked. Capabilities successfully supporting immediate warfighter needs should transition to JCIDS when the urgency passes. This transition should involve evaluating technology success, reviewing operational concept, and determining other potential material solutions that could better support the requirement as technology matures.

Funding and the Planning, Programming, Budgeting, and Execution System

Technology transition in hybrid warfare is dependent upon a funding process that can support both aspects of hybrid warfare; short-term and long-term capability needs. Funding is critical to the timely procurement of weapon systems as well as timely initiation of research and development to fill capability gaps with new material solutions. The Planning, Programming, Budgeting and Execution System (PPBE) “is the DoD internal methodology used to allocate resources to capabilities deemed necessary to accomplish the Department’s missions.”⁴¹ The PPBE is a time consuming process that consists of four phases: planning phase, programming phase, budgeting phase, and execution phase. The PPBE is a deliberate process developed to support long-term planning against a Cold War enemy. New funding initiatives to support new technology solutions need to be institutionalized to support hybrid warfare.

Supplemental funding, outside of the PPBE, has been a key to technology insertion in OEF and OIF. This funding has been used to fulfill the urgent requirements that have arisen out of the need to defeat an enemy engaged in irregular warfare. Supplemental appropriations provide additional funding to programs in the current fiscal year. As in past wars, supplemental funding was used to fund the additional unplanned costs of deploying troops for OEF and OIF. The use of supplemental funding has not decreased over time, however, as in past conflicts. In addition, the “line separating baseline and supplemental line items has been blurred to include R&D and procurement;

items that traditionally have not been allowed in supplemental war funding.”⁴² Supplemental funds are not expected to continue in the future. As a result, the current PPBE process will be stressed to support technology insertion in hybrid warfare.

As it is structured, the PPBE process requires that the S&T and acquisition community plan for technology investments two years prior to their transition. This structure is difficult, as it requires the S&T community to predict when promising technologies will be sufficiently matured.⁴³ As a result, promising technologies can languish in the S&T base until the necessary funding can be obtained. This structure impacts all aspects of hybrid warfare as it can delay insertion of new capabilities into programs of record and also delay introduction of new breakthrough technologies. Various approaches have been recommended to allow emerging technologies to be transitioned into the acquisition process as soon as it is available. One approach is to set aside “future funding in an engineering development account based on metrics for transition established by a memorandum of agreement.”⁴⁴ An engineering development account allows funding of technology transition as soon as it is available.

More funding flexibility is essential to rapid technology development as exemplified by the Joint IED Defeat Organization (JIEDDO). JIEDDO has demonstrated the ability to rapidly acquire and adapt new technologies to the Counter-IED fight, which is a major aspect of today’s irregular warfare. One of the keys to JIEDDO’s success in rapidly acquiring systems is the Joint IED Defeat fund that was formed by Congress. The Joint IED Defeat fund is what JIEDDO calls “three year uncolored money for use to spend on everything from basically fundamental S&T all the way to procurement”⁴⁵ LTG Metz, former director of JIEDDO, has stated that the fund “allows us a tremendous amount of flexibility to solve problems.”⁴⁶ This fund allows JIEDDO to develop and acquire systems much more quickly than if they had to follow the more bureaucratic PPBE process. The funding can extend over a three-year period and can be used for any category of RDT&E efforts. This flexible funding capability allows JIEDDO to fund technology transition as soon as the technology is ready.

The establishment of a separate acquisition fund is not without precedent. The Deputy Secretary of Defense established the Rapid Acquisition Fund (RAF) in 2004 as a way to provide funding and respond to current year urgent operational needs. The JRAC

oversees the fund. DoD initiated a budget item number for the RAF for FY 2009 and beyond.⁴⁷ The role of the JRAC and RAF should be expanded to allow for not only the funding of current year acquisitions but also the funding to transition emerging technologies from the S&T base to the acquisition base.

The advantage of alternate funding solutions for technology development such as supplemental funding and three year un-colored money is speed of technology transition necessary for irregular type warfare. An example of such speed is the procurement of the MRAP vehicle. The disadvantage of alternative funding solutions outside of the PPBE is that such processes tend to be reactionary and lack the checks and balances of the PPBE process. The use of such funds often allows DoD to avoid tradeoffs between requirements that are funded or rejected.⁴⁸ Also, the life cycle costs of a new system are generally much higher than the initial procurement cost funded through supplemental funding. These additional operating and disposal costs for the system, which are not documented in the supplemental funding request, are often quite large and will have to be included in future baseline budgets.⁴⁹ Hybrid warfare demands an agile funding process for technology insertion. Adjustment to the DoD technology funding process needs to support rapid technology insertion for irregular warfare. At the same time, the process must use limited funds most effectively to make the right technology decisions and tradeoffs for long-term needs. Alternative funding solutions for technology insertion should be institutionalized but remain limited in scope and quantity as compared to the PPBE.

Transition to the Defense Acquisition Process

The Defense Acquisition System is the third decision support system impacting technology transition. The current deliberate acquisition process defines evolutionary acquisition as “the preferred DoD strategy for rapid acquisition of mature technology for the user.”⁵⁰ The strategy is to deliver capabilities in increments as the different technologies mature. Each separate increment has military utility delivering capabilities as defined in requirements documents with objectives and thresholds established by the user. The deliberate evolutionary requirements and acquisition process flow is shown in Figure 1.

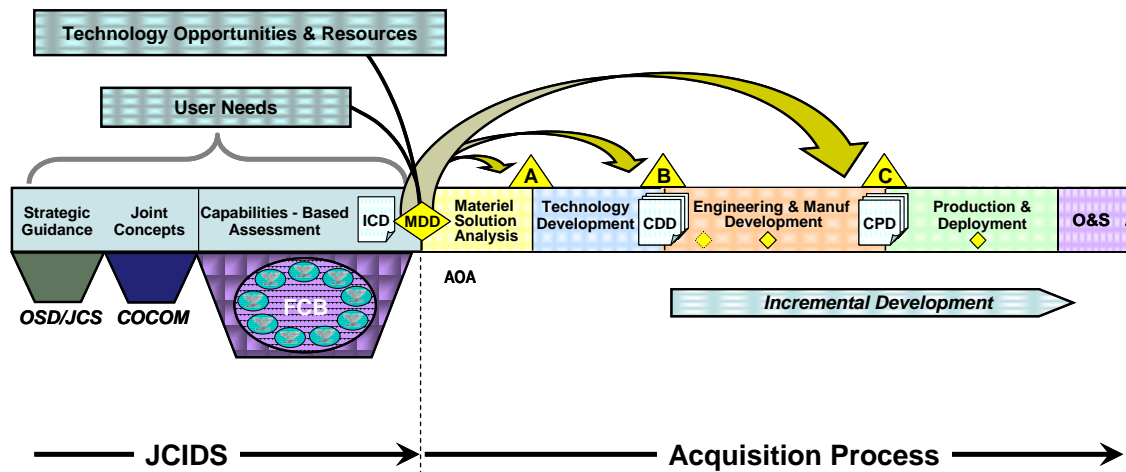


Figure 1. Defense Acquisition Management System.⁵¹

The process is initiated with the user created Initial Capabilities Document (ICD), which defines the capability gap requiring a material solution. The Milestone Decision Authority (MDA), who is the designate individual with overall responsibility for a program, then proceeds to conduct an analysis of potential material solutions. The MDA conducts the Material Development Decision (MDD), which is a mandatory entry point into the acquisition process.⁵² At the MDD, the ICD is reviewed as well as the preliminary concept of operations and description of the needed capabilities. After the MDD, the MDA “may authorize entry into the Acquisition Management System at any point consistent with phase specific entrance criteria and statutory requirements.”⁵³ The S&T transition point is determined based upon technical maturity and program needs. Bypassing any of the phases assumes more technical risk. At the MDD, the MDA may direct entrance into the material solution analysis phase of the process and approve the analysis of alternatives (AoA) study guidance. The AoA reviews potential technological solutions from all areas to include the DoD S&T base as well as foreign and commercial sources. The AoA also assesses critical technology elements (CTEs) required for each material solution, assesses technology maturity and integration risk of the different potential solutions. The material solution analysis ends with completion of the AoA and recommends material solution options for the capability need identified in the ICD.

The Technology Development Phase begins after Milestone A, at which time a Technology Development Strategy (TDS) is approved. The TDS describes how the

material solution will be divided into acquisition increments based on the maturity of technology. The TDS must also include plans for two or more competing prototypes; ensuring necessary competition to reduce technical risk. Life cycle sustainment of the technology, performance, and technical maturity are all key factors used during this phase in determining the best solution. The Technology Development phase is completed upon identification of an affordable program or increment; the technology and manufacturing process have been demonstrated in a relevant environment; and the risks in manufacturing have been identified.⁵⁴ During this phase, the user completes the Capability Development Document.

Milestone (MS) B initiates the Engineering and Manufacturing Development (EMD) Phase. MS B is the initiation of an acquisition program and completes the transition of technology from the S&T base and into the acquisition process. In evolutionary acquisition, each increment will have its own milestone B. A critical technology element may be used in Milestone B only after it has demonstrated maturity in a relevant environment. The entire acquisition process, with its milestones and decision point is established to ensure program success, to keep costs down, and to ensure that the right technology is chosen. The expected end result is a program that is effective, suitable, and safe. This process of technology insertion into a program of record differs from the rapid technology insertion process of ad-hoc activities that accept more risk of failure. Each process has a role in hybrid warfare.

There are numerous barriers to transition from the S&T base to the acquisition process. Stringent requirements that do not support evolutionary acquisition are one barrier. Many advocates supporting rapid acquisition make the statement that the 80% solution is good enough. This is often the strategy used by rapid fielding organizations. However, this statement often ignores the reality that not all formally generated CDD requirements can be broken up incrementally and allow for meeting that requirement over multiple increments of a system. Many requirements, such as windows compatibility, interoperability, and computer security cannot be measured in percentages but are measure in terms of pass/fail or go/no-go.⁵⁵ Such requirements cannot be broken up incrementally and must be met 100% or waived if unattainable. Some of these requirements may also be Key Performance Parameters (KPP) that must be achieved in

order for the program to progress. In cases where the requirement does not allow for incremental delivery, technical maturity must be achieved in all aspects of the system in order for the first increment of a capability to be fielded.

The rapid requirements generation process that has been created to support OEF and OIF will support evolutionary acquisition and should be retained and institutionalized. The JUONS/ONS or REF 10-Liner requirements documents do not have KPPs like those contained in a CDD. Systems fielded by organizations such as JIEDDO and REF can be brought to the field based upon a Safety Release and a Capability and Limitations (C&L) report conducted by the Army Test and Evaluation Command. This C&L reports what the system can do and what its limitations are. The user in the field has the discretion of accepting or rejecting the system based upon this report.

Time and urgency are critical factors in the requirements process for hybrid warfare and should be added as a consideration. To support more rapid technology insertion, the focus of the technology needs to be on the capabilities it provides at the given technology level attainable at specific times. If the need is urgent, then the material solution is limited to only what mature technology is available in the military or commercial sector. The decision to procure the material solution is based upon its capabilities and limitations and not based upon its ability to meet all requirements. Such urgency will normally only occur in times of conflict where life or limb is at stake. In these cases, the first delivery, normally delivered based upon and ONS/JUONS document will be based upon technical maturity at the time. In parallel a second increment; meeting a broader set of requirements can be developed. The CDD, with its details of requirements and more thorough analysis, is better suited in cases where time is available to allow technologies to mature.

Another barrier to transition is synchronization of transition schedules. Technical feasibility is defined using technology readiness levels (TRL). Technologies must generally demonstrate a TRL of six in order to be transitioned to acquisition programs.⁵⁶ Programs must coordinate closely to ensure that schedules are aligned for technology insertion. Technology must be ready to be inserted at the key milestone where the program is ready to accept it. Misalignment occurs if the technology is not ready to

integrate at a key point in the system integration process. The negative result of misalignment can be major delays in the program or the program moving forward with the technological capability.

The Technology Assessment and Transition Management Process (TATM) process was developed through cooperation of Army's PEO Aviation; the Aviation and Missile Research, Development and Engineering Center; and the Army Aviation Warfighting Center. The TATM formalizes coordination between the user, combat developer, S&T and acquisition PM to successfully manage technical transition from the S&T base to the acquisition process. The TATM goal is to ensure "technologies being developed meet warfighter demands and are transitioned effectively."⁵⁷ The TATM has been adopted by a number of other agencies to include Robotic Systems Joint Project Office and Program Executive Office Soldier and is a standard process by which these Army organizations share technology requirements, technology assessments, and manage technology transitions.⁵⁸

The TATM process is based upon a structured system engineering process and uses an integrated product team (IPT) structure that is responsible for overseeing its execution. The PM, S&T, user, and sustainment communities execute the TATM process through a working IPT. The working IPT supports communication and coordination among the key stakeholders. The user representative, from TRADOC communicates documented user requirements and force operating capabilities. The PM provides the program definition that includes approved requirements and key milestone schedules. The S&T project lead provides descriptions of the technology, operational capabilities it could provide, current technology maturity level using technology readiness levels (TRLs), and the current plan for maturing the technology. The sustainment stakeholder provides a sustainment plan assessing the logistical impact and support required for the technology.⁵⁹

The TATM process utilizes memorandums of agreement to document understanding and agreements among the stakeholders at different stages of technology development. The interest TTA documents agreement among the stakeholders that the technology is of interest to the warfighter. The follow-on intent TTA documents all parties agree that the technology will support and operational requirement or provide the

warfighter with an advanced capability. The commitment TTA documents that the stakeholders agree on a commitment to transition the technology, to include providing the necessary funding and resources. Close coordination and a formal memorandum of agreement assist in ensuring that the S&T base is developing the right technology and that the technology has a path towards transition to a program of record.

Risk aversion is a significant barrier to technology transition. The ongoing irregular warfare requires rapid insertion of technology by the S&T community. The ideal solution for technology transition is for the insertion of disruptive technology providing large technological leaps in the shortest amount of time. These game changing technologies provide a technological advantage over the greatest period of time. Unfortunately, rapid technology insertion of this disruptive game changing technology runs contrary to the current structure imposed upon the acquisition community, which requires strict maintenance of cost and schedule. The current deliberate acquisition system lowers the risk of fielding a system that is not operationally suitable or effective. The process is designed to ensure that the system will achieve its intended purpose once fielded. The deliberate acquisition process achieves low risk through rigorous developmental and operational testing; using technology readiness levels to ensure technical maturity prior to incorporation; and detailed requirements documents. All these steps lower risk that a system will not work and help achieve a 100% solution. However, this also adds time to the acquisition process.

Cost is a key driver for incorporating mature technologies. A 2006 Government Accounting Office study found that programs beginning with immature technologies experienced an average cost growth of 34.9%, while programs beginning with mature technologies experienced a cost growth of only 4.8%.⁶⁰ PMs are thus focused on fielding proven technologies on time and within cost. They are less inclined to risk trying to field unproven technologies, which may have promising capability but increased risk.⁶¹

The risk of failure must be accepted in order to achieve the rapid technology insertion needed for hybrid warfare. JIEDDO is an example of a rapid acquisition organization that follows this principle. LTG Metz, Director of JIEDDO, when speaking of using fielding of a system as the measurement of success has said, “if this is our measurement of success: something comes in the front door, it must go out the back door;

then I don't think we are looking at all the available options. We have to accept some risk that some of those ideas are going to fail and that it's acceptable to invest appropriate levels of funding in an initiative that may fail.”⁶²

Significant lessons have been learned to expedite technology transition. Close coordination of the user community, S&T base, and the acquisition PM are the most critical. The formalized processes such as TATM assist in this coordination endeavor. For rapid technology transition, acquisition PMs need the same tools as the ad-hoc rapid fielding agencies. These tools include an institutional acceptance of the risk of failure as well as the ability to equip in small quantities.

Recommendations

The Army's S&T insertion process must have two capabilities. First, it must be capable of providing forces with technological superiority for conventional warfare. Second, it must be capable of rapidly inserting technologies required to defeat an adaptive enemy engaged in irregular warfare. The following recommendations are to institutionalize these capabilities into the S&T base and the technology transition process.

Strengthen Ties to Commercial Industry and its Technology

The primary focus of the S&T base must be on utilizing commercial technologies. Commercial industry and not government laboratories are the engine of advanced technologies and rapid technological change. The commercial sector provides the most diverse types of technology and the most rapid developments. For these reasons, a strong commercial technology base is best suited to support the requirements of hybrid warfare. Successful technology insertion requires a continued focus on the commercial sector and continued research partnerships with universities and industry. The Army S&T base must be continuously aware of technological advances to best support the warfighter with the most technologically superior equipment. The numerous programs in place such as SBIR, IR&D, CRADA, and CTAs must be continued to leverage commercial technologies.

Resource Science and Technology Advisors within Staff Elements of Operational Commands

Rapid technology insertion requires a direct linkage between the warfighter and the S&T base. S&T advisors, working on staffs of combatant commanders, play a critical role in communicating warfighter needs directly to the S&T base and informing operational commanders on technologies that may be available. The quick reaction cells stood up by RDECOM must be resourced to enable the rapid response to the warfighter engaged in combat operations.

Close Coordination between the Science and Technology Community, Program Manager, and Other Stakeholders

Close coordination and a formal memorandum of agreement assist in ensuring that the S&T base is developing the right technology and that the technology has a path towards transition to a program of record. Significant lessons have been learned to expedite technology transition. Close coordination of the user community, S&T base, and the acquisition PM are the most critical. The formalized processes such as TATM assist in this coordination endeavor.

Provide Successful Rapid Acquisition Tools to the Program Manager

The technology insertion process must continue to provide the US with the best conventional force capabilities in the world. Similarly, the technology insertion process must provide rapid incremental technologies to defeat an adaptive and asymmetric enemy. Fortunately, many of the ad-hoc processes created to defeat the irregular enemy in Afghanistan and Iraq have proven successful. Acquisition PMs need the same tools as utilized by the ad-hoc rapid fielding organizations such as REF and JIEDDO to provide time critical material solutions. The rapid requirements generation process, concept of equipping and flexible funding all support the rapid technology insertion needed in irregular warfare. These processes should be permanently institutionalized into the existing decision support systems affecting defense acquisition.

Institutionalize the Concept of Equipping vs. Fielding into the Acquisition Process

The best approach to mitigate risk aversion and to minimize the cost impact of failure is to institutionalize the concept of *equipping* vs. *fielding* into the acquisition process. Rapid fielding organizations such as REF equip specific requesting units with a limited quantity of systems for use in an operational environment. Equipping involves a smaller scale procurement quantity, limited testing, and limited logistical support in comparison to a full-scale fielding through the deliberate acquisition process. Equipping has some great advantages over a full scale fielding in the right instances. First, equipping limits the risk of excessive waste of funds if the system fails. A second advantage is that the operational concepts for usage of the system can be developed and refined in the hands of the warfighter. An evaluation can then be made if the technology is the right solution and then it can be moved into a program of record. The REF equipping process has proven itself to be a successful method of rapid technology insertion. The process should be expanded to acquisition PMs.

Flexible Funding

Hybrid warfare demands an agile funding process for technology insertion. Adjustment to the DoD technology funding process needs to support rapid technology insertion for irregular warfare. At the same time, the process must use limited funds most effectively to make the right technology decisions and tradeoffs for long-term needs. Alternative funding solutions for technology insertion should be institutionalized but remain limited in scope and quantity as compared to the PPBE. The role of the JRAC and RAF should be expanded to allow for not only the funding of current year acquisition but also the funding to transition emerging technologies from the S&T base to the acquisition base.

Institutionalize Requirements Generation for Hybrid Warfare

For hybrid warfare, both JCIDS and JRAC type processes are needed. The JRAC process should be used only for urgent requirements where a rapid technology insertion on a limited scale is needed. The technology to be inserted must be judged on the capabilities it can immediately provide. JCIDS should remain as the process for

generating more stringent requirements for the future forces. In addition, the two processes must be linked. Capabilities successfully supporting immediate warfighter needs should transition to JCIDS when the urgency passes. This transition should involve evaluating technology success, reviewing operational concept, and determining other potential material solutions that could better support the requirement as technology matures.

Conclusion

Two major aspects impact the ability to insert technology into the hands of the warfighter: the S&T base and the technology transition process. The nature of hybrid warfare requires that both aspects be reformed. The Army has shown success in developing ad-hoc processes and organization to provide rapid incremental improvements needed in the current irregular warfare engagements of Afghanistan and Iraq. At the same time, the S&T base has continued to develop the disruptive technologies to defeat future conventional enemies.

The dual focus required for technology insertion in hybrid warfare must be institutionalized. This reform should not require separate research and development organizations or acquisition organizations. Such a structure will hinder coordination and waste scarce resources. Existing organizations can and must support both aspects of hybrid warfare. Successful technology transition requires a close working relationship between the S&T community, acquisition PMs, and the user community. Coordination and communication among people will be the most critical component of successful technology insertion in hybrid warfare.

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